



U.S. Department  
of Transportation

Federal Aviation  
Administration

# Advisory Circular

**Subject:** Engineered Materials Arresting Systems  
(EMAS) for Aircraft Overruns

**Date:** 10/6/00

**AC No:** 150/5220-22

**Initiated by:** AAS-100

**Change:** 1

1. **PURPOSE.** This Change provides additional guidance in the installation of **EMAS**.

exiting the runway at 70 knots, has been added to paragraph 6.b.

2. **PRINCIPAL CHANGES.** Guidance in installing **EMAS** where the area available is longer than required, based on stopping the design aircraft

The change number and date of change is shown at the top of each page. The changed material is indicated by lines in the left-hand column margin.

## PAGE CONTROL CHART

Remove Pages	Dated	Insert Pages	Dated
1 & 2	8/21/98	1	8/21/98
		2	10/6/00

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**1. PURPOSE.** This advisory circular (AC) contains standards for the planning, design, and installation of Engineered Materials Arresting Systems (EMAS) in runway safety areas. Engineered Materials means high energy absorbing materials of selected strength, which will reliably and predictably crush under the weight of an aircraft.

**2. BACKGROUND.** Aircraft can and do overrun the ends of runways, sometimes with disastrous results. An overrun occurs when an aircraft passes beyond the end of a runway during an aborted takeoff or while landing. The majority of such overruns by air carrier aircraft come to rest within 1000 feet of the runway end and between the extended edges of the runway. Data on aircraft overruns over a **12-year** period from 1975 to 1987 indicate that a large majority of all overruns (approximately 90%) occur at exit speeds of 70 knots or less (Reference 7, Appendix 2). In order to minimize the hazards of overruns, the Federal Aviation Administration (FAA) incorporated into airport design standards the concept of a safety area beyond the runway end. To meet the standards, the safety area must be capable, under normal (dry) conditions, of supporting aircraft that overrun the runway without causing structural damage to the aircraft or injury to its occupants. Besides enhancing airport safety, the safety area provides greater accessibility for emergency equipment after an overrun incident. There are many runways, **particularly** those constructed prior to the adoption of the safety area standards, where natural obstacles (bodies of water or sharp drop-offs), local development (roads and railroads), or environmental constraints (wetland encroachment), make the construction of a standard safety area impracticable. There have been accidents at some of these airports where the ability to stop an overrunning aircraft within the runway safety area would have prevented major damage to aircraft and injuries to passengers.

Recognizing the difficulties associated with achieving a standard safety area at all airports, the FAA undertook research programs on the use of various materials for arresting systems and, in conjunction with industry, conducted a series of field tests utilizing an instrumented Boeing 727 aircraft. As a result of the data obtained from these test programs, the Port Authority of New York and New Jersey (PANY/NJ), in 1997, installed an **EMAS** comprised of cellular cement on the Runway 4R safety area at John F. Kennedy International Airport. This prototype system is being monitored to provide information on system longevity.

**3. APPLICATION.** At some airports, reconstruction of a runway requires its safety areas to be brought up to current standards to the extent practicable. Of course, conformance with current standards is desirable at all airports, even when not required by regulation. Occasionally, however, it may not be practicable to achieve a standard safety area as specified in Tables 3-1, 3-2, and 3-3 of **AC 150/5300-13, Airport Design**. In these situations, Appendix 14, **Declared Distances**, of that AC provides an alternative means of enhancing safety. The declared distance alternative allows an airport owner to declare what portions of an operational runway are available to satisfy the aircraft's accelerate-stop and landing distance requirements, with runway beyond these "declared distances" available as runway safety area. However, the use of declared distances at some airports may result in the inability to accommodate aircraft that are currently in use at that airport. In such a situation, installing an **EMAS** may be another way of enhancing safety. An **EMAS** is **NOT** a substitute for, nor equivalent to, any length or width of runway safety area and does not affect declared distance calculations. An **EMAS** is also not intended to meet the definition of a **stopway** as provided in **AC 150/5300-13**.

The guidelines and standards contained herein are recommended by the FAA for the design of **EMAS**. This AC is not mandatory and does not constitute a regulation. It is issued for guidance purposes and to outline a method of compliance. **One** may elect to follow an alternate method, provided it is also found by the Federal Aviation Administration (FAA) to be an acceptable means of complying with Title 14, Code of Federal Regulations (CFR), Chapter I, FAA. Therefore, mandatory terms such as "shall" or "must" used herein- apply only to those who seek to demonstrate compliance by use of the specific method described by this AC, or for those for whom the use of these guidelines is mandatory, such as those installing an **EMAS** funded under Federal grant assistance programs.

#### 4. RELATED READING MATERIAL.

Appendix 2 contains a listing of documents with supplemental material relating to **EMAS**. These documents contain certain information on materials evaluated, as well as design, construction, and testing procedures utilized to date. Testing and data previously generated under FAA studies referenced in Appendix 2 may be used as input to an **EMAS** design without further justification.

**5. PLANNING CHARTS.** The purpose of Figures A1- through A1-4 is to allow a preliminary analysis, providing **sufficient** information to determine whether to proceed **with** a detailed engineering design of an optimum **EMAS** installation. They are intended to be used as a preliminary screening tool only. They are not **sufficient** for final design, which must be customized for each installation. The charts illustrate estimated **EMAS** stopping distance capabilities for various aircraft types. The design used in each chart is optimized specifically for the aircraft noted on the chart and assumes the availability of brakes and reverse thrust. It should be noted that the absence of either would result in longer stopping distances.

**a . Example 1.** Assume a candidate runway has a runway safety area that extends 500 feet beyond the end of the runway and the design aircraft is a DC-9 (or similar). Figure A1-1 shows that an **EMAS** 500 feet in length (including a 100' jet blast buffer) is capable of stopping a DC-9 within the confines of the system at runway exit speeds of up to 94 knots.

**b. Example 2.** Assume the same runway safety area but assume the design aircraft is a DC-10 (or similar). Figure A1-3 shows an **EMAS** of the same length, but designed for larger aircraft, can stop the DC-10 within the confines of the system at runway exit speeds of up to 72 knots.

**6. SYSTEM DESIGN REQUIREMENTS.** For purposes of design, the **EMAS** can be considered **fixed** by its function and frangible since it is designed to fail at a specified impact load. Therefore, an **EMAS** is not considered an obstruction under 14 CFR Part 77, *Objects Affecting Navigable Airspace*. The following system design requirements shall prevail for all **EMAS** installations.

**a. Concept.** An **EMAS** is designed to stop an overrunning aircraft by exerting predictable deceleration forces on its landing gear as the **EMAS** material crushes. It must be designed to minimize the potential for structural damage to aircraft, since such damage could result in injuries to passengers and/or affect the predictability of deceleration forces.

**b. Location.** An **EMAS** is located beyond the end of the runway, centered on the extended runway centerline. It will usually begin at some distance from the end of the runway to avoid damage due to jet blast and short landings (Figure 1). This distance will vary depending on the available area and the **EMAS** materials. Where the area available is longer than required for installation of an **EMAS** designed to stop the design aircraft at an exit speed of 70 knots, the **EMAS** should be placed as far from the runway end as practicable. Such placement decreases the possibility of damage to the system from short overruns or undershoots, and results in a more economical system by considering the deceleration capabilities of the existing runway safety area.

**c. Design Method.** An **EMAS** design shall be supported by a validated design method, which can predict the performance of the system. The design aircraft is defined as that aircraft using the associated runway that imposes the greatest demand upon the **EMAS**. To the extent practicable, however, the **EMAS** design should consider the range of aircraft expected to operate on the runway. In some instances, this may be preferable to optimizing the **EMAS** for the design aircraft. The design method shall be derived from field or laboratory tests. Testing may be based on passage of either an actual aircraft or equivalent single wheel load through a test bed. The design must consider multiple aircraft parameters, including but not necessarily limited to allowable aircraft gear loads, gear configuration, tire contact pressure, aircraft center of gravity, and aircraft speed. The model must calculate imposed aircraft gear loads, g-forces on aircraft occupants, deceleration rates, and stopping distances within the arresting system. Any rebound of the crushed material that may serve to lessen its effectiveness must be considered.

**d. Operation.** The **EMAS** shall be a passive system.

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